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Reducing Graphene-Metal Contact Resistance via Laser Nano-welding

Kamran Keramatnejad

University of Nebraska-Lincoln, kkeramatnejad2@unl.edu

H. Rabiee Golgir

University of Nebraska-Lincoln, rabiee@huskers.unl.edu

Y. S. Zhou

University of Nebraska-Lincoln, yzhou5@unl.edu

D. W. Li

University of Nebraska-Lincoln, dli8@unl.edu

X. Huang

University of Nebraska-Lincoln

See next page for additional authors

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Authors

Kamran Keramatnejad, H. Rabiee Golgir, Y. S. Zhou, D. W. Li, X. Huang, and Yongfeng Lu

University of
Nebraska-Lincoln

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K. Keramatnejad, H. Rabiee Golgir, Y. S. Zhou, D. W. Li, X. Huang, and Y. F. Lu*
Department of Electrical and Computer Engineering, Univ. of Nebraska-Lincoln
Lincoln, Nebraska 68588-0511, United States

E-mail: ylu2@unl.edu

Website: <http://lane.unl.edu>

Laser Assisted
Nano-Engineering Lab

MOTIVATION AND CHALLENGES

Flexible electronics

Transparent electrodes

Optoelectronics

X The large graphene-metal contact resistance is a major limitation for development of graphene electronics.

X graphene behaves as an insulator for out-of-plane carrier transport to metallic contacts.

PROPOSED SOLUTION

Laser nano-welding of graphene to the metal contacts

- Laser-induced formation of defects.
- Increase the chemical reactivity of graphene.
- Avoid unwanted damage to channel region.

❖ Realization of a strong G-M bonding at laser-induced defects.

METHODS

I. Fabrication of the four-point probe structures

II. Laser nano-welding of graphene

- Wavelength: 514 nm.
- Laser Fluence: 1.6×10^3 J/cm².

- Temperature: 400 °C.
- Time: 1 hr.
- Pressure: 1-5 mTorr (Ar purge).

RESULTS AND DISCUSSION

I. Reducing the Contact resistance via laser nano-welding

- Slight increase in R_C for all samples after the laser-irradiation.
- Significant reduction of R_C values after the annealing.
- R_C values as low as $2.57 \Omega \cdot \mu\text{m}$ obtained via laser nano-welding method.

II. Structural characterization using I_D/I_G Raman mapping

- A rise in the I_D/I_G ratio was observed only at the edges of graphene, where laser irradiation was performed.
- No change was observed at the channel region and the middle of graphene-metal interface.
- Performance degradation was avoided, due to selective mechanism of the laser-irradiation.

III. Carrier mobility

- Slight reduction in the mobility after the laser irradiation.
- Increased mobility after the thermal annealing.
- Improved carrier injection efficiency, due to the bonding formation at the edges of graphene.

CONCLUSIONS

- ✓ Laser nano-welding was developed and led to R_C reductions of up to **84%**.
- ✓ Localized laser irradiation at the edges of graphene led to the formation of chemically active **point defects**.
- ✓ Precise structural modifications and formation of **G-M bonding** led to improved carrier efficiency in graphene devices.

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